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NOAA Technical Report NMFS SSRF-699

Seasonal Surface Currents Off the Coasts of Vancouver Island and Washington as Shown by Drift Bottle Experiments, 1964-65

W. JAMES INGRAHAM, JR. and JAMES R. HASTINGS

SEATTLE, WA
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W. JAMES INGRAHAM, JR. and JAMES R. HASTINGS[1]

ABSTRACT

Release of a total of 1,044 drift bottles during four periods from April 1964 to January 1965 off the coasts of Washington and Vancouver Island, British Columbia, indicate a seasonal reversal of flow, southward in April and July and northward in November and January, within 200 km (108 nautical miles) of the coast. This study supplements those conducted off the Oregon and California coasts by other agencies.

INTRODUCTION

The Northwest Fisheries Center of the National Marine Fisheries Service, Seattle, Wash. (Biological Laboratory of the Bureau of Commercial Fisheries prior to 1970), has conducted far-ranging research on fisheries problems throughout the subarctic Pacific region from local coastal waters of Washington to the central North Pacific Ocean and the Bering Sea. Oceanographic conditions that affect the distribution and abundance of fish stocks have been studied in conjunction with fisheries research since 1955. Studies of local ocean currents off the coasts of Washington and Vancouver Island were emphasized in the oceanographic research program from 1963 to 1964 (Ingraham 1967). The purpose here is to summarize results of drift bottle experiments in 1964 and 1965 which were not reported by Favorite and Fisk (1971) nor by Fisk (1971).

Although the general oceanic flow may appear as a simple onshore movement, eddies form complex flow patterns within about 500 km (270 nautical miles) of shore as the land boundary causes the current to diverge toward the north and south. These complexities were shown by dynamic computations and from records of water properties for several isolated studies at different times (Doe 1955; Bennett 1959; Reid 1960; Budinger et al. 1964). Other studies, using drift bottles to estimate surface water drift, have shown some details of flow within 200 km (108 nautical miles) of shore where reversals occur, with flow from the north in summer and from the south in winter (Dodimead and Hollister 1958; Schwartzlose 1963; Burt and Wyatt 1964).

Four oceanographic cruises were conducted aboard the RV *George B. Kelez* in April, July, and November 1964 and January 1965, which helped provide areal continuity in nearshore ocean sampling between the Oregon and Canadian coasts.[2] During these cruises 1,044 drift bottles were released along two lines normal to shore—one from Willapa Bay, Wash., to Cobb Seamount and the other from Cobb Seamount to Estevan Point, Vancouver Island, B.C. Twelve corked, unballasted, short-necked (17 cm long with a 4½-cm base) drift bottles were released at 21 stations during each cruise. Ballast sand was not placed in the bottles to save handling time. These particular empty bottles already floated about 80% submerged and any improvement would be minor compared to other inherent errors in the method. Only minimum speeds are inferred by drift bottle data because there is no way of knowing how long the bottle was on the beach before recovery. Each contained a folded data card with instructions in English, Russian, and Japanese and four-digit serial numbers ranging from 6001 to 7044. A reward ($1.00) was offered for the return of each card. Recoveries from each cruise are discussed separately below.

APRIL 1964

From 20 to 28 April 1964, a total of 288 drift bottles was released at 21 stations and 77 recoveries (27%) have been reported (Fig. 1, Table 1). The recoveries suggest two distinct regions with different flow features: 1) a southerly drift at speeds of 15 to 30 cm/s about 167 km (90 nautical miles) wide nearshore and 2) an offshore region of questionable flow from which no recoveries have been reported. These features are the same along both of the tracklines.

The 41 recoveries from the six inshore stations along the trackline normal to the Washington coast were from the Washington and Oregon coasts southeast of the release locations. All 7 of the recoveries from the nearest inshore station were reported from the southern Washington coast, whereas, all of the remaining 34 recoveries were from the Oregon coast. These reflect a dominant southerly flow of surface waters at this time. A northward flow was reported in April 1959 and 1960 (Schwartzlose 1963), and mixed flow toward the north and south was reported in April 1961 and 1962 (Burt and Wyatt 1964).

Along the trackline normal to the west coast of Vancouver Island, 36 recoveries came from 72 releases at the six inshore stations. Of the 15 recoveries reported from the three stations shoreward of the 100-fathom curve, four were recovered on the west coast of Vancouver Island north of the drop location, indicating some localized northerly flow of surface waters along the west coast of Vancouver Island. The remainder of the recoveries from these three stations and 20

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[2]Ingraham, W. J., Jr., and D. M. Fisk. 1966. Oceanographic observations off the coasts of Washington and British Columbia—April, July, and November, 1964 and January 1965. Unpubl. manuscr., 96 p., Northwest Fisheries Center, Natl. Mar. Fish. Serv., NOAA, Seattle, WA 98112.

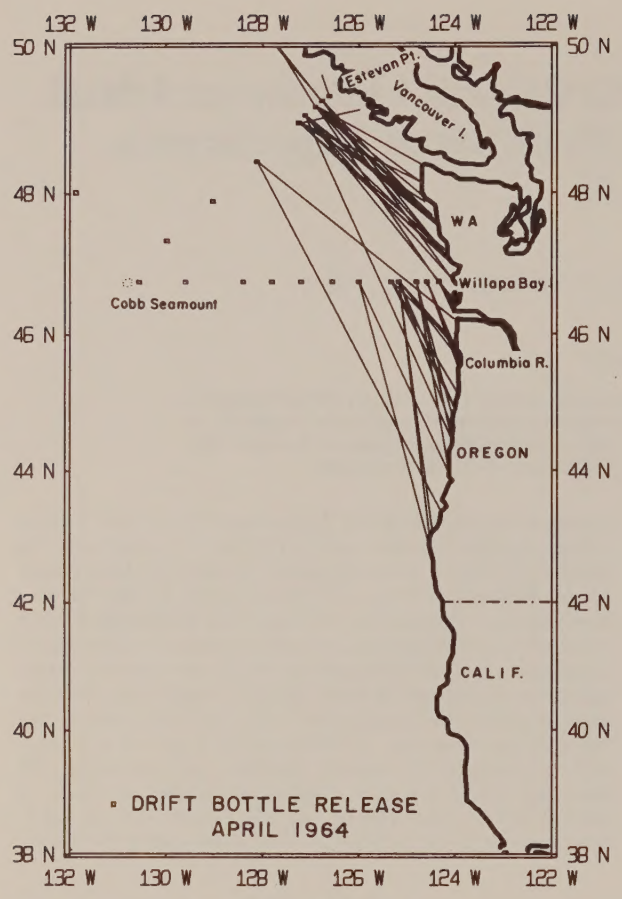

Figure 1.—Locations of drift bottle releases and recoveries, RV *George B. Kelez*, 20-28 April 1964.

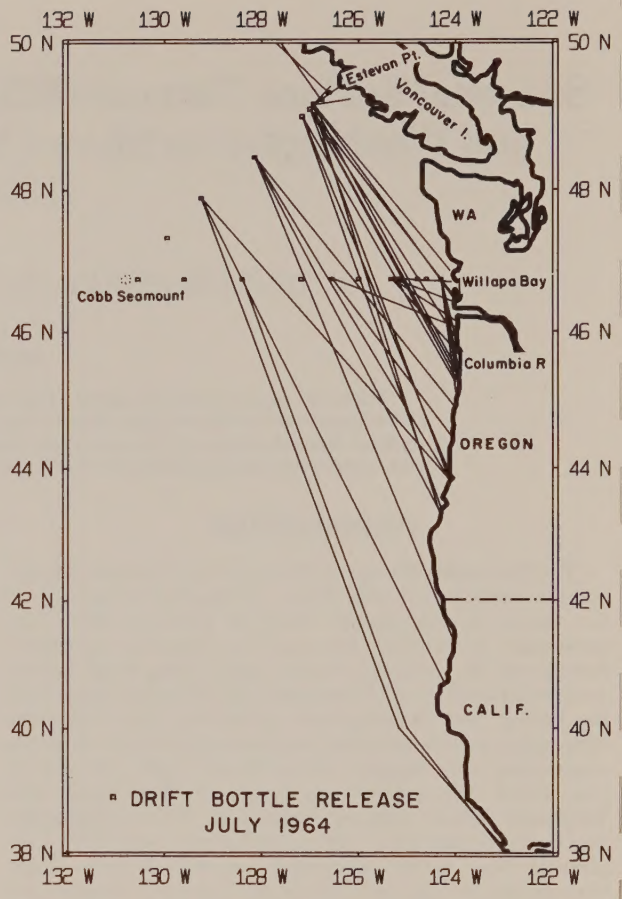

Figure 2.—Locations of drift bottle releases and recoveries, RV *George B. Kelez*, 20-26 July 1964.

of the 21 recoveries from the three seaward stations were recovered along the Washington and Oregon coasts. No recoveries to date have been reported from the two offshore stations along this trackline.

On 14 May 1964, a transponding telemetry buoy was launched at lat. 48°00'N, long, 131°53'W (Favorite et al. 1965). An additional 48 drift bottles were released at this site, but no recoveries have been reported. The buoy drifted east-southeast (115° true direction) for 595 km (320 nautical miles) at an average speed of 11 cm/s. This suggests the drift bottles released offshore may have moved onshore but, before coming ashore, they were carried offshore into the eastern edge of the subtropical North Pacific gyre.

JULY 1964

There were 37 recoveries (16%) from 228 releases at the 19 stations occupied during the July 1964 cruise (Fig. 2, Table 2). They numbered less than one-half the recoveries reported for the April 1964 cruise. In general, the fewer returns are consistent with the expected usual July conditions of northerly winds which transport surface water offshore. Recoveries are probably associated with sporadic short-term events in which southerly winds transport bottles that have remained nearshore onto the beach. Features of surface drift are very similar to those of April—a slower southeasterly flow at 5 to 11 cm/s (minimum) within about 185 km (100 nautical miles) of shore and no returns from offshore.

Recoveries were made from only 4 of the 11 stations along the trackline normal to the Washington coast during this cruise. Of the 13 recoveries, 6 drifted from the station closest to shore onto the northern Oregon coast. No recoveries to date have been reported from releases at the next three seaward stations, but four recoveries, ranging from southern Washington to northern Oregon, have been made from the fifth station from shore. From the remaining four stations on this trackline, there were only three recoveries; all were from south of the mouth of the Columbia River, with the recovery from the most seaward station coming from northern California (lat. 38°N).

Almost twice as many recoveries were reported from the trackline normal to the west coast of Vancouver Island as the trackline normal to the Washington coast—24 recoveries from 96 released. Nine recoveries were released from the three stations nearest Vancouver Island, five from the west coast of Vancouver Island. Two of these five recoveries were from northwest of the launch site, indicating some deviation from the general southerly flow along the coast during this time of year. The other three recoveries were made near Estevan Point on Vancouver Island. The 19 other recoveries were made along the coast from central Washington to northern California. It appears that during this season the

Table 1.—Release and recovery locations for drift bottles released in April 1964.

Serial number	Date released	Location		Number released	Number recovered	Serial number	Date recovered	Location	
		Lat. N	Long. W					Lat. N	Long. W
6001-6012	4/20/64	46°45′	124°20′	12	7	6001	3/10/66	46°26′	124°03′
						6002	4/22/64	46°24′	124°03′
						6003	4/22/64	46°26′	124°03′
						6005	5/1/64	46°18′	124°02′
						6006	4/22/64	46°24′	124°03′
						6009	4/22/64	46°18′	124°02′
						6011	5/7/64	46°19′	124°02′
6013-6024	4/20/64	46°45′	124°35′	12	10	6013	4/26/64	45°35′	123°56′
						6014	4/25/64	45°33′	123°57′
						6015	4/26/64	45°37′	123°53′
						6017	4/26/64	45°28′	123°53′
						6018	4/25/64	45°33′	123°57′
						6019	4/24/64	45°39′	123°56′
						6020	4/24/64	45°39′	123°56′
						6022	4/24/64	45°39′	123°56′
						6023	4/25/64	45°39′	123°56′
						6024	4/25/64	—	— *
6025-6036	4/20/64	46°45′	124°48′	12	3	6027	5/7/64	44°46′	124°03′
						6028	5/4/64	44°23′	124°03′
						6035	5/8/64	43°57′	124°07′
6037-6048	4/21/64	46°45′	125°20′	12	9	6037	5/8/64	44°55′	124°00′
						6039	5/8/64	45°10′	123°58′
						6040	5/7/64	44°55′	124°00′
						6041	5/8/64	44°55′	124°00′
						6042	5/7/64	44°55′	124°00′
						6043	5/7/64	44°55′	124°00′
						6045	5/4/64	45°49′	123°57′
						6046	5/8/64	44°55′	124°00′
						6047	5/7/64	45°49′	123°57′
6049-6060	4/21/64	46°45′	125°10′	12	9	6050	5/9/64	44°35′	124°03′
						6051	5/9/64	44°55′	124°00′
						6052	5/5/64	45°39′	123°56′
						6053	7/21/64	43°04′	124°35′
						6054	5/7/64	44°55′	124°00′
						6055	5/6/64	45°45′	123°57′
						6058	5/17/64	42°46′	124°29′
						6059	5/22/64	42°47′	124°29′
						6060	5/3/64	45°49′	123°57′
6061-6072	4/23/64	46°45′	126°00′	12	3	6064	6/7/64	42°44′	124°29′
						6070	6/9/64	43°57′	124°07′
						6072	12/24/66	—	— *
6073-6084	4/23/64	46°45′	126°33′	12	0	—	—	—	—
6085-6096	4/25/64	46°45′	127°12′	12	0	—	—	—	—
6097-6108	4/25/64	46°45′	127°48′	12	0	—	—	—	—
6109-6120	4/25/64	46°45′	128°24′	12	0	—	—	—	—
6121-6132	4/26/64	46°45′	129°36′	12	0	—	—	—	—
6133-6144	4/26/64	46°45′	130°34′	12	0	—	—	—	—
6145-6156	4/26/64	47°20′	129°59′	12	0	—	—	—	—
6157-6168	4/27/64	47°53′	129°02′	12	0	—	—	—	—
6169-6180	4/27/64	48°26′	128°07′	12	3	6171	5/24/64	46°14′	124°04′
						6172	5/24/64	46°13′	124°02′
						6174	6/28/64	43°22′	124°15′

Table 1.—Release and recovery locations for drift bottles released in April 1964, continued.

Serial number	Date released	Location Lat. N	Location Long. W	Number released	Number recovered	Serial number	Date recovered	Location Lat. N	Location Long. W
6181-6192	4/27/64	48°58′	127°15′	12	8	6183	5/25/64	47°02′	124°08′
						6184	5/31/64	46°58′	124°00′
						6185	6/26/64	49°09′	125°59′
						6186	7/2/64	47°10′	124°10′
						6187	5/23/64	—	— *
						6188	5/25/64	48°09′	124°44′
						6189	6/13/64	47°52′	124°38′
						6192	5/30/64	—	— *
6193-6204	4/27/64	49°04′	127°07′	12	10	6193	5/23/64	47°41′	124°29′
						6194	5/23/64	47°34′	124°21′
						6195	5/23/64	47°34′	124°21′
						6197	5/28/64	46°47′	124°04′
						6198	5/23/64	47°05′	124°09′
						6199	5/28/64	47°31′	124°20′
						6200	5/28/64	46°31′	124°04′
						6201	5/23/64	47°34′	124°21′
						6202	6/18/64	44°27′	124°04′
						6204	5/23/64	47°34′	124°21′
6205-6216	4/28/64	49°11′	126°54′	12	9	6206	6/18/64	47°05′	124°09′
						6207	6/20/64	47°41′	124°29′
						6208	10/5/64	50°48′	128°26′
						6209	5/30/64	47°57′	129°40′
						6210	5/27/64	48°09′	124°44′
						6211	6/21/64	46°26′	124°03′
						6213	5/28/64	47°05′	124°09′
						6214	6/6/64	48°22′	124°37′
						6216	6/18/64	47°33′	124°21′
6217-6228	4/28/64	49°16′	126°46′	12	5	6217	7/18/64	47°34′	124°22′
						6220	5/12/64	50°08′	127°55′
						6223	6/1/64	46°47′	124°04′
						6227	7/26/64	50°06′	127°51′
						6228	5/29/64	47°04′	124°08′
6229-6240	4/28/64	49°20′	126°37′	12	1	6229	9/27/65	49°37′	126°46′
6241-6288	5/14/64	48°00′	131°53′	48	0	—	—	—	—

*Card returned—unable to ascertain recovery location.

farther from shore the releases were made, the farther southward the travel before recovery.

NOVEMBER 1964

The cruise during November 1964 yielded the fewest recoveries (9%), 24 of the 276 released (Fig. 3, Table 3). The few recoveries prevent defining any clear pattern of circulation for this time of the year, but a generally slow northward flow is evident from all but one recovery.

There were 18 recoveries (12%) from 156 releases along the trackline normal to the Washington coast. Two of the bottles released at the station closest to shore drifted into the Strait of Juan de Fuca and were recovered at the southern tip of Vancouver Island. These recoveries were reported 5 wk after their release and suggest a general northerly flow along the coast at 5 to 8 cm/s (minimum) with an appreciable onshore component, particularly at the entrance to the Strait of Juan de Fuca. The single recovery from the adjacent station along this trackline was reported from Montague Island in Prince William Sound, Alaska (lat. 59°50'N, long. 147°45'W), whereas the recovery from the station nearest Cobb Seamount was reported from the central portion of the west coast of Vancouver Island. Of the 10 remaining stations along this trackline, recoveries have been reported from only 3, and all but 1 of the 14 recoveries were from the Washington or Vancouver Island coasts.

Only six recoveries (5%) have been reported from 120 releases at the 10 stations along the trackline normal to Vancouver Island. All of these were from only five stations, and all recoveries were made north of the release area; four of the six recoveries were in Laredo Sound (about lat. 52°30'N, long. 129°W).

JANUARY 1965

The winter cruise from 13 to 18 January 1965 was unique because recoveries were made from nearly all the 21 release stations. A total of 252 drift bottles was released and 76 were recovered (Fig. 4, Table 4)—a 30% recovery. Speed and direction of surface flow are indicated by first recoveries from each station that fell into three different time groups: 1) recoveries within 11 to 24 days released within 130 km (70 nautical miles) offshore indicate the extension of the

Table 2.—Release and recovery locations for drift bottles released in July 1964.

Serial number	Date released	Location		Number released	Number recovered	Serial number	Date recovered	Location	
		Lat. N	Long. W					Lat. N	Long. W
6289-6300	7/20/64	46°45′	124°18′	12	6	6289	8/22/64	45°26′	123°58′
						6291	8/21/64	45°24′	123°58′
						6293	8/8/64	45°12′	123°56′
						6295	8/9/64	45°55′	123°53′
						6299	8/13/64	45°28′	123°56′
						6300	8/12/64	45°03′	123°59′
6301-6312	7/20/64	46°45′	124°36′	12	0	—	—	—	—
6313-6324	7/21/64	46°45′	124°47′	12	0	—	—	—	—
6325-6336	7/21/64	46°45′	125°10′	12	0	—	—	—	—
6337-6348	7/21/64	46°45′	125°20′	12	4	6339	8/9/64	46°42′	124°05′
						6341	8/13/64	46°25′	124°03′
						6347	8/15/64	45°40′	123°56′
						6348	8/ /64[1]	46°09′	124°00′
6349-6360	7/22/64	46°45′	126°00′	12	0	—	—	—	—
6361-6372	7/22/64	46°45′	126°33′	12	2	6361	12/24/64	46°02′	123°56′
						6367	12/11/64	44°27′	124°04′
6373-6384	7/22/64	46°45′	127°11′	12	0	—	—	—	—
6385-6396	7/23/64	46°45′	128°24′	12	1	6388	1/1/65	38°00′	123°00′
6397-6408	7/23/64	46°45′	129°36′	12	0	—	—	—	—
6409-6420	7/23/64	46°45′	130°33′	12	0	—	—	—	—
6421-6432	7/24/64	47°20′	129°57′	12	0	—	—	—	—
6433-6444	7/24/64	47°53′	129°15′	12	3	6435	12/3/64	40°43′	124°14′
						6436	1/28/65	38°04′	123°00′
						6438	1/11/69	43°50′	124°08′
6445-6456	7/25/64	48°27′	128°09′	12	4	6448	12/31/64	43°51′	124°09′
						6449	11/15/64	41°23′	124°03′
						6451	11/28/64	43°20′	124°19′
						6455	12/29/64	44°54′	124°01′
6457-6468	7/25/64	49°20′	126°37′	12	1	6463	8/24/64	50°08′	127°55′
6469-6480	7/26/64	49°14′	126°46′	12	1	6476	8/23/64	50°12′	127°49′
6481-6492	7/26/64	49°10′	126°56′	12	7	6481	4/3/66	49°25′	126°35′
						6482	11/2/64	49°15′	126°10′
						6483	10/20/64	49°25′	126°23′
						6487	12/1/64	45°25′	123°57′
						6490	12/31/64	46°26′	124°03′
						6491	9/25/64	46°52′	124°07′
						6492	11/10/64	43°18′	124°23′
6493-6504	7/26/64	49°06′	127°00′	12	5	6494	11/23/68	45°18′	123°59′
						6495	12/30/64	46°30′	124°02′
						6497	9/20/64	45°53′	123°59′
						6501	9/20/64	45°21′	123°57′
						6502	10/14/64	43°50′	124°08′
6505-6516	7/26/64	49°00′	127°10′	12	3	6508	10/17/64	43°22′	124°17′
						6509	12/21/64	45°16′	124°00′
						6514	12/1/64	43°56′	124°08′

[1] Card returned, without date, during August 1964.

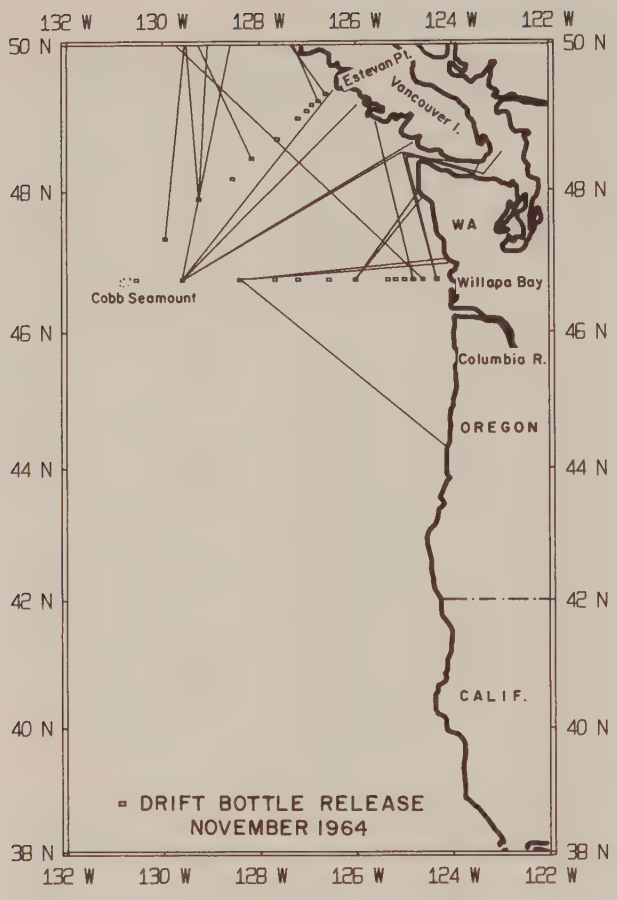

Figure 3.—Locations of drift bottle releases and recoveries, RV *George B. Kelez*, 6-16 November 1964.

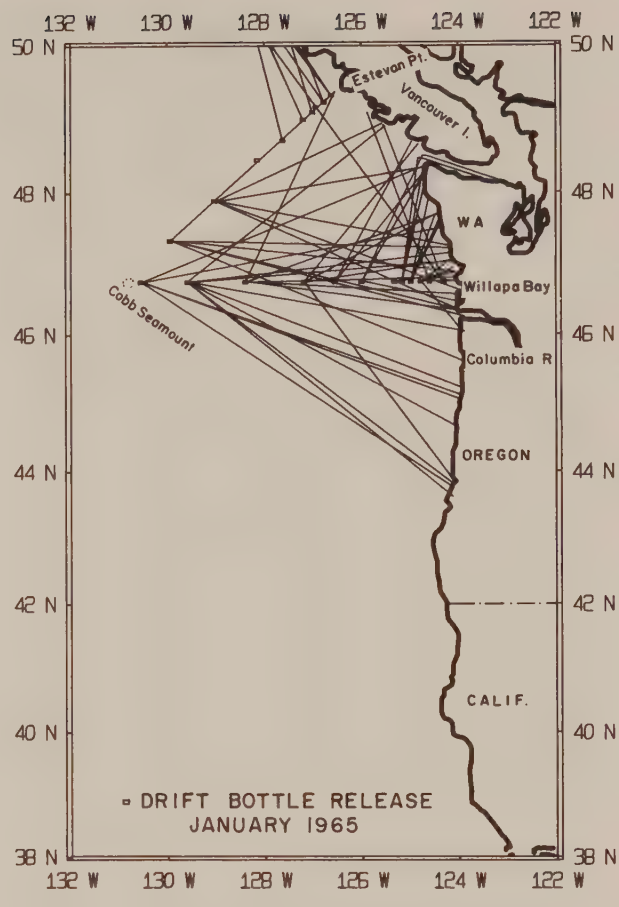

Figure 4.—Locations of drift bottle releases and recoveries, RV *George B. Kelez*, 13-17 January 1965.

Davidson Current flowing northward off the coast of Washington at 11 to 15 cm/s (minimum) and flowing toward the northwest off the coast of Vancouver island at 13 to 17 cm/s (minimum); 2) recoveries 41 to 44 days after release indicate the current still had a net northerly component as far as 445 km (240 nautical miles) offshore; and 3) recoveries 60 to 70 days after release near Cobb Seamount were reported both north and south of their release latitude. Many late recoveries (70 days) were made from most of the stations beyond 130 km (70 nautical miles), which showed a wide range of recovery points from northern Washington to southern Oregon. Their significance is questionable, but multiple late recoveries probably suggest a large dispersion of bottles from any one release station with a possible long residence close to shore once the nearshore zone is reached, followed by sporadic recoveries depending on the local onshore transport.

SUMMARY

As part of an ocean survey of local seasonal conditions off the coasts of Washington and Vancouver Island, 12 drift bottles were released at each of 21 stations along two lines from Cobb Seamount normal to the shorelines of each coast during April, July, and November 1964 and January 1965. These experiments extend our knowledge of drift of coastal surface water northward of the area of earlier studies by Scripps Institute of Oceanography and Oregon State University, providing data for another time period.

Early recoveries from both lines of stations within about 60 days of release clearly showed the dominant seasonal patterns of flow nearshore. Of the April releases 27% were recovered, compared to lower recoveries in similar studies off Oregon (13%) and off California (5%). The percentage of recoveries decreased during July to 16% and was lowest in November at 9%, but January recoveries were highest at 30%. Within about 150 to 200 km (81 to 108 nautical miles) of shore, the surface drift was southerly during April and July but speeds of first returns decreased from a maximum of 15 to 30 cm/s (minimum) in April to 5 to 11 cm/s (minimum) in July. The direction of flow reversed sometime before mid-autumn, for a well-developed northward flow at speeds of 5 to 8 cm/s (minimum) extended along both the Washington and Vancouver Island coasts beyond lat. 50°N in November. The northward flow was also present in January but speeds had doubled. Very little may be inferred about nearshore flow from bottles released beyond 200 km (108 nautical miles) from the coast. Those released in November or January may be recovered but move in a long complex path. Those released in April or July appear to have been caught in the North Pacific gyre as shown by Dodimead and Hollister (1958).

Table 3.—Release and recovery locations for drift bottles released in November 1964.

Serial number	Date released	Location		Number released	Number recovered	Serial number	Date recovered	Location	
		Lat. N	Long. W					Lat. N	Long. W
6517-6528	11/6/64	46°45′	124°19′	12	2	6517	12/14/64	48°25′	123°24′
						6518	12/12/64	48°23′	123°55′
6529-6540	11/7/64	46°45′	124°36′	12	1	6534	12/4/64	59°50′	147°45′
6541-6552	11/7/64	46°45′	124°48′	12	1	6545	12/2/68	48°57′	125°35′
6553-6564	11/8/64	46°45′	124°59′	12	0	—	—	—	—
6565-6576	11/8/64	46°45′	125°10′	12	0	—	—	—	—
6577-6588	11/9/64	46°45′	125°20′	12	0	—	—	—	—
6589-6600	11/9/64	46°45′	126°00′	12	4	6591	12/12/64	47°54′	124°37′
						6593	12/12/64	48°00′	124°41′
						6595	12/12/64	48°00′	124°41′
						6599	12/12/64	47°54′	124°37′
6601-6612	11/10/64	46°45′	126°33′	12	0	—	—	—	—
6613-6624	11/10/64	46°45′	127°11′	12	0	—	—	—	—
6625-6636	11/10/64	46°45′	127°40′	12	0	—	—	—	—
6637-6648	11/11/64	46°45′	128°24′	12	3	6638	2/15/65	46°59′	124°08′
						6641	2/9/65	47°03′	124°09′
						6648	2/22/65	44°17′	124°05′
6649-6660	11/11/64	46°45′	129°36′	12	7	6649	4/14/65	48°40′	124°49′
						6651	1/14/65	49°23′	126°28′
						6652	1/23/65	48°32′	122°58′
						6656	7/31/65	51°31′	128°06′
						6657	1/15/65	49°11′	125°58′
						6658	1/10/65	49°10′	126°00′
						6659	12/29/67	49°09′	126°01′
6661-6672	11/13/64	46°45′	130°33′	12	0	—	—	—	—
6673-6684	11/14/64	47°20′	129°57′	12	1	6682	2/12/65	52°45′	129°06′
6685-6696	11/14/64	47°53′	129°15′	12	2	6685	6/28/65	53°10′	129°55′
						6687	5/22/65	52°25′	128°50′
6697-6708	11/14/64	48°10′	128°33′	12	0	—	—	—	—
6709-6720	11/15/64	48°27′	128°09′	12	1	6710	6/19/67	56°00′	133°55′
6721-6732	11/15/64	48°43′	127°37′	12	0	—	—	—	—
6733-6744	11/15/64	49°00′	127°11′	12	0	—	—	—	—
6745-6756	11/15/64	49°06′	127°00′	12	0	—	—	—	—
6757-6768	11/16/64	49°11′	126°54′	12	0	—	—	—	—
6769-6780	11/16/64	49°14′	126°46′	12	1	6770	4/5/65	52°32′	129°02′
6781-6792	11/16/64	49°20′	126°37′	12	1	6784	6/15/65	52°38′	129°20′

This study shows the seasonal reversal of flow in nearshore surface water to the geographical limits of the data, but the northerly extent of the reversal is not known at this time. The study also suggests the seaward extent of the coastal flow to be 150 to 200 km (81 to 108 nautical miles).

ACKNOWLEDGMENTS

The assistance of F. Favorite, Oceanography Program Leader, Division of Marine Fish and Shellfish, Northwest Fisheries Center, is gratefully acknowledged. The cooperation of the scientific party and crew of the RV *George B. Kelez* is greatly appreciated.

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Table 4.—Release and recovery locations for drift bottles released in January 1965.

Serial number	Date released	Location		Number released	Number recovered	Serial number	Date recovered	Location	
		Lat. N	Long. W					Lat. N	Long. W
6793-6804	1/13/65	46°45′	124°18′	12	3	6793	3/11/65	51°58′	128°27′
						6796	5/3/65	48°56′	125°32′
						6797	3/6/65	—	— *
6805-6816	1/13/65	46°45′	124°36′	12	2	6811	5/17/65	46°57′	124°08′
						6814	7/11/65	49°06′	125°52′
6817-6828	1/13/65	46°45′	124°47′	12	3	6818	5/30/65	46°03′	123°57′
						6822	5/29/65	47°05′	124°08′
						6827	5/16/65	46°46′	124°04′
6829-6840	1/14/65	46°45′	124°59′	12	8	6830	1/25/65	47°41′	124°29′
						6831	1/25/65	47°41′	124°29′
						6832	1/27/65	47°37′	124°21′
						6833	1/25/65	47°41′	124°29′
						6836	1/27/65	47°54′	124°38′
						6837	1/25/65	47°40′	124°21′
						6838	1/30/65	47°40′	124°23′
						6839	1/25/65	47°41′	124°29′
6841-6852	1/14/65	46°45′	125°10′	12	5	6845	1/30/65	48°22′	124°37′
						6846	1/29/65	48°22′	124°37′
						6849	2/20/65	48°23′	124°43′
						6850	2/25/65	48°07′	123°12′
						6852	1/28/65	48°22′	124°37′
6853-6864	1/14/65	46°45′	125°20′	12	1	6854	2/15/65	46°53′	124°06′
6865-6876	1/15/65	46°45′	126°00′	12	6	6865	2/16/65	46°28′	124°03′
						6866	2/13/65	48°22′	124°37′
						6869	2/8/65	48°22′	124°37′
						6870	4/7/65	48°22′	124°38′
						6874	3/5/65	48°02′	122°37′
						6876	2/8/65	48°22′	124°37′
6877-6888	1/15/65	46°45′	126°33′	12	2	6878	4/10/65	48°42′	124°58′
						6888	2/28/65	48°22′	124°37′
6889-6900	1/15/65	46°45′	127°11′	12	4	6892	5/24/65	43°51′	124°08′
						6895	5/16/65	47°04′	124°08′
						6896	2/28/65	47°44′	124°25′
						6897	8/8/65	48°40′	124°50′
6901-6912	1/16/65	46°45′	128°24′	12	5	6903	5/15/65	46°20′	124°03′
						6904	3/26/65	46°34′	124°03′
						6905	5/2/65	46°49′	124°04′
						6906	6/27/65	49°23′	126°32′
						6911	2/27/65	47°43′	124°25′
6913-6924	1/16/65	46°45′	129°36′	12	8	6915	5/2/65	43°37′	124°10′
						6916	3/27/65	43°49′	123°57′
						6918	5/8/65	48°55′	125°31′
						6919	2/27/65	47°10′	124°09′
						6920	3/26/65	45°13′	123°56′
						6921	2/26/65	46°02′	123°53′
						6922	2/27/65	47°03′	124°08′
						6924	5/9/65	44°39′	124°03′
6925-6936	1/16/65	46°45′	130°33′	12	6	6926	5/10/65	48°23′	124°41′
						6927	3/26/65	45°03′	123°58′
						6929	3/27/65	45°03′	123°58′
						6932	5/7/65	43°46′	124°09′
						6933	5/2/65	47°31′	124°21′
						6936	4/22/65	45°07′	123°57′

Table 4.—Release and recovery locations for drift bottles released in January 1965, continued.

Serial number	Date released	Location Lat. N	Location Long. W	Number released	Number recovered	Serial number	Date recovered	Location Lat. N	Location Long. W
6937-6948	1/17/65	47°20′	129°57′	12	6	6937	5/17/65	46°53′	124°06′
						6938	12/7/67	49°23′	126°32′
						6939	3/17/65	46°15′	123°53′
						6940	5/17/65	45°37′	123°56′
						6941	5/9/65	46°21′	124°03′
						6944	5/14/65	47°13′	124°11′
6949-6960	1/17/65	47°53′	129°02′	12	6	6949	6/4/65	46°37′	123°58′
						6950	3/16/65	48°22′	124°37′
						6955	5/26/65	46°21′	124°02′
						6957	5/3/65	48°57′	125°35′
						6958	11/10/65	48°22′	124°37′
						6959	5/22/65	47°15′	124°11′
6961-6972	1/17/65	48°27′	128°09′	12	0	—	—	—	—
6973-6984	1/18/65	48°43′	127°37′	12	1	6977	2/8/65	50°47′	128°26′
6985-6996	1/18/65	49°00′	127°12′	12	2	6992	9/3/67	50°44′	128°23′
						6995	2/3/65	50°47′	128°26′
6997-7008	1/18/65	49°06′	127°00′	12	1	6997	8/17/65	52°11′	128°30′
7009-7020	1/18/65	49°10′	126°56′	12	0	—	—	—	—
7021-7032	1/18/65	49°14′	126°46′	12	2	7022	3/12/65	50°48′	128°26′
						7028	3/1/65	52°10′	128°30′
7033-7044	1/18/65	49°20′	126°37′	12	5	7035	7/26/65	50°01′	127°23′
						7036	5/5/65	50°03′	127°25′
						7039	1/21/65	50°00′	127°18′
						7041	3/5/65	50°03′	127°25′
						7042	9/22/65	49°58′	127°15′

*Card returned—unable to ascertain recovery location.

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